5.0 BEST AVAILABLE CONTROL TECHNOLOGY ANALYSIS

New Source Review (NSR) regulations [South Carolina Regulation 62.5 Standard No. 7] requires that Best Available Control Technology (BACT) be applied to minimize the emissions of compounds from a new major source or a major modification of an existing major source in attainment and non-attainment areas, respectively. This section presents the BACT evaluation for SO_2. No other pollutants exceed the NSR significance levels as a result of the proposed project.

The kraft mill TRS gases are collected in the LVHC and HVLC systems and combusted in the combination boilers. These gases are required by federal regulations (MACT and NSPS) to be collected in the LVHC and HVLC systems, and although the primary purpose of the combination boilers is to produce steam for mill operations, the boilers also combust the LVHC and HVLC gases from the kraft mill.

Section 5.1 presents an overview of the top-down BACT approach used in this application, and the BACT analyses for SO_2 from the kraft mill pulping and evaporator system modifications is presented in Section 5.2.

5.1 Top-Down BACT Approach

BACT is defined in the Clean Air Act as *an emissions limit based on the maximum degree of emissions reduction for each pollutant...which the permitting authority determines, on a case by case basis, taking into account energy, environmental, and economic impacts and other costs, is achievable for such facility through the application of production processes and available methods, systems, and techniques….* Four key aspects of the definition are worthy of notice:

- BACT is an "emissions limit" based on a control technology - not the control technology itself; or, if technological or economic limitations on the application of measurement methodology to an emissions unit would not be feasible, a design, equipment, work practice, operation standard, or combination thereof may be prescribed.
- BACT takes into account various costs associated with implementing pollution controls: economic, environmental (air, water, or solid waste), energy, and other impacts.

- BACT includes and, in fact, focuses on "production processes" along with add-on controls.
- BACT is intended to be a case-by-case evaluation, implying individual case evaluations and decisions, not rigid, pre-set guidelines.

The top-down BACT approach starts with the most stringent (or top) technology that has been applied to the same unit at other similar emission source types and provides a basis for rejecting the technology in favor of the next most stringent technology or proposing it as BACT.

Step 1

The first step is to define the spectrum of process and/or add-on control alternatives potentially applicable to the subject emissions unit. The following categories of technologies are addressed in identifying candidate control alternatives:

- Demonstrated add-on control technologies applied to the same emissions unit at other similar source types;
- Add-on controls not demonstrated for the source category in question but transferred from other source categories with similar emission stream characteristics;
- Process controls such as combustion or alternate production processes;
- Add-on control devices serving multiple emission units in parallel; and
- Equipment or work practices, especially for fugitive or area emission sources where add-on controls are not feasible.

A review of the RACT/BACT/LAER Clearinghouse (RBLC) is the first step in this process.

Step 2

The second step in the top-down approach is to evaluate the technical feasibility of the alternatives identified in the first step and to reject those that can be demonstrated as infeasible based on an engineering evaluation or on chemical or physical principles. The following criteria are considered in determining technical feasibility: previous commercial-scale demonstrations, precedents based on permits, requirements for similar sources, and technology transfer.

Step 3

The third step is an assessment and documentation of the emissions limit achievable with each technically feasible alternative considering the specific operating constraints of the emission units undergoing review. After determining what control efficiency is achievable with each alternative, the alternatives are rank-ordered into a control hierarchy from most to least stringent.

Step 4

The fourth step is to evaluate the cost/economic, environmental, and energy impacts of the top or most stringent alternative. To reject the top alternative, it must be demonstrated that this control alternative is infeasible based on the impacts analysis results. If a control technology is determined to be technically infeasible or infeasible based on high cost effectiveness, or to cause adverse energy or environmental impacts, the control technology is rejected as BACT and the impact analysis is performed on the next most stringent control alternative. In analyzing economic cost effectiveness, the annualized control cost (in dollars per ton of emissions removed) was compared with commonly accepted values for cost effective emission controls.

Step 5

The fifth and final step in the analysis is the consideration of toxic pollutant impacts on the control alternative choice. Toxics concerns are usually important only if an adverse toxic emissions impact results from the selected alternative. As in step 4, if an adverse toxic emissions impact is determined, the alternative is rejected in favor of the next most stringent alternative.

5.2 Kraft Mill Sulfur Dioxide from TRS Combustion

The net increase in sulfur dioxide (SO_2) emissions from the proposed modification is the result of the increased throughput to the kraft mill. The non-condensable gases (NCG's) from the kraft mill are collected within the LVHC and HVLC collection system. Both collection systems are combusted in the No. 1 and No. 2 combination boilers to comply with NSPS Subpart BB.

Potential control technologies for SO_2 emissions include pre-combustion TRS controls or post-combustion add-on SO_2 control technologies. As part of the new kraft fiberline project in 2001, AbiBow determined that the installation of pre-combustion scrubbers within the HVLC system was technically infeasible due to the high flow conditions, the required pressure drop across the scrubbing system, and potential impact to the combustion controls required by NESHAP standards. AbiBow currently uses a TRS caustic scrubber on the LVHC system prior to the combination boilers to reduce TRS and SO_2 emissions prior to combustion.

5.2.1.1 Demonstrated Control Technologies

AbiBow has evaluated control technologies for sulfur dioxide emissions from the kraft mill through the review of the RBLC database, the South Coast Air Quality Management District's (AQMD) BACT Guidelines, and the EPA Clean Air Technology Center's technical bulletins or fact sheets.

The RBLC contained limited SO_2 determinations for pulp mill sources. A summary of the BACT determinations are listed in Table 5.1.

Table 5.1
Summary of SO_2 RBLC Determinations
Existing Mills

RBLCID	FACILITY	COUNTY	ST	RATE	UNITS	CONTRL DECSRIPTION
AL-0099	MEAD CONTAINERBOARD	JACKSON	AL	120 170	PPM @ 8% O2 LB/H	(A) INCINERATION
PA-0177	P.H. GLATFELTER COMPANY	YORK	PA	145 968	PPM T/YR	(N) *none listed*

5.2.1.1.1 <u>RBLC Determination AL-0099</u>

RBLC determination AL-0099 is for the Mead Containerboard neutral sulfite semi-chemical (NSSC) pulp mill in Jackson County, Alabama. The selected control technology for the digester, evaporator, and washer gases was incineration in the facility power boiler.

The BACT SO_2 emission limit is 170 lb/hr, or approximately 745 tons per year. Based on the RBLC digester throughput of 1,700,000 lb BLS/day (850 TBLS/day), and assuming a conversion factor of 3,500 lb BLS per air dried ton pulp (ADTP), this equates to a pulping capacity of approximately 485 ADTP/day. This represents an SO_2 emission rate of approximately 8.4 lb/ADTP.

The NSSC cooking process is milder and shorter than the kraft cooking process, generating much lower volumes of non-condensable gases and much lower emissions. The SO_2 emissions from a kraft mill may be more than twice the emissions from a NSSC pulp mill of the same capacity, or more than 16.8 lb/ADTP from a kraft pulp mill.

5.2.1.1.2 RBLC Determination PA-0177

RBLC determination PA-0177 is for the P. H. Glatfelter Company kraft pulp mill in York County, Pennsylvania. The selected control technology for the high-volume low-concentration (HVLC) gases was incineration in the facility recovery furnace.

The BACT SO_2 emission limit is 968 tons/year, or approximately 221 lb/hour. Based on the bleached kraft pulping capacity of 650 ADTP/day reported by the company in their 2010 Annual Report, and assuming 95% yield across the bleaching system, this equates to a pulping capacity of approximately 685 ADTP/day. This represents an SO_2 emission rate from the HVLC system of approximately 7.7 lb/ADTP.

There is no BACT emission limit or other information in the RBLC regarding the SO_2 emissions from combusting low-volume high-concentration (LVHC) gases at the P. H. Glatfelter Company. Typically, the LVHC system emissions are much higher than the HVLC system emissions. The SO_2 emissions from incinerating all the kraft pulping non-condensable gases (HVLC plus LVHC) may exceed 15.4 lb/ADTP.

5.2.1.2 Potential Control Technologies

Emission control technologies potentially applicable to the removal or destruction of sulfur dioxide from the post-control air stream were initially evaluated based upon technical feasibility. Technologies determined to be technically infeasible were excluded from further evaluation. Control technologies evaluated include scrubbers and flue gas desulfurization.

5.2.1.2.1 Wet Scrubbers

Scrubbers involve the use of packed columns or trays to facilitate contact between either a water or chemical solution to facilitate the preferential absorption of pollutants from the air stream to scrubbant solution for collection, treatment, and disposal. According to the EPA (EPA-452/F-03-015), absorption (scrubbing) may be used for gaseous streams containing high VOC concentrations, especially for water soluble compounds such as methanol, ethanol, isopropanol, etc. Scrubbers are more commonly employed for use in controlling low dust loadings or soluble inorganic vapors. Wet scrubbers are employed to remove SO_2 from exhaust streams with a control efficiency averaging 90 percent (EPA-452/F-03-012).

According to the EPA (EPA-452/F-03-012, EPA-452/F-03-015, and EPA-452/F-03-017), wet flue gas desulfurization (FGD) may be achieved using impingement or tray scrubbers. The spent scrubbing solution is filtered to remove the calcium sulfite/sulfate, and the solids are sent to a landfill for disposal.

Traditional wet scrubbers are designed to control air flow ranging between 1,000 and 100,000 standard cubic feet per minute. Inlet gas temperatures range from 4ºC to 370ºC. Exhaust flow rates from Combination Boiler No. 1 or No. 2 are more than double the traditional scrubber operating range, while the exhaust temperature shall be near the upper limit of the technology. Although SO_2 may be removed from the post-combustion stream, the cooling of the exhaust stream may result in a visible plume with a potential for equipment corrosion.

Due to the low SO_2 emissions generated from the combustion of non-combustible gases and the high volume of air flow from the combination boiler, the anticipated control efficiency for a wet scrubbing system is anticipated to achieve no more than 90 percent control.

5.2.1.2.2 Flue Gas Desulfurization (FGD) – Dry

Dry flue gas desulfurization (FGD) removes SO_2 by using a spray dryer to inject lime slurry into the flue gas. Within the flue gas stream, SO_2 and the lime slurry react to form calcium sulfite and calcium sulfate. The calcium sulfite/sulfate is then removed from the exhaust gases using an ESP or other particulate control device.

AbiBow currently employs the use of an electrostatic precipitator (ESP) to control particulate emissions from each combination boiler. Installing a dry FGD would result in the ESP collecting both fly ash from the bark combustion and calcium sulfite/sulfate from the spray dryer, requiring a larger ESP. The powerhouse at the AbiBow Catawba mill is "land locked" and has very limited space. To build a FGD system and larger ESP for each combination boiler, major demolition and construction activities would be required to create the necessary space. These include relocating the kraft mill condensate stripper, wood chip and bark storage piles, chip truck dumper, chip conveyors and transfer stations, utility pipe bridges, and several roads. Based upon the major demolition or construction requirements to employ FGD, AbiBow has determined that the dry FGD process is technically infeasible.

5.2.1.3 Control Technology Cost Estimates

Upon review of the RBLC and the NEET databases, AbiBow has determined the sole technology that is technically feasible for SO_2 control is a wet scrubber system following the No.1 and No. 2 combination boilers. The existing process configuration minimizes SO_2 emissions through the reduction of TRS from the LVHC system gases prior to combustion. The cost-effectiveness of post-combustion controls was determined by dividing the incremental annual cost difference by the theoretical SO_2 emissions reduction in tons per year for the control option.

The capital costs for the installation of a wet scrubbing system were determined based upon vendor supplied information. Formulas as provided in Section 5.2 of the EPA Air Pollution Control Cost Manual, Sixth Edition (APCCM) do not account for the high volumetric air flow rate and are not applicable to equipment costs. Basic equipment costs for a wet scrubber system are based on the air flow and pollutant loading. The purchased equipment cost includes the equipment costs plus additional costs associated with instruments and controls, taxes, and freight. Additional costs, not specifically included in vendor information, have been estimated using formulas within the APCCM.

The total capital investment for the wet scrubber system is estimated based on a series of factors applied to the purchased equipment cost to obtain direct and indirect installation costs. These costs are then added to the purchased equipment cost to determine the total capital investment.

Direct annual costs include operating and supervisory labor, operating materials, replacement parts, maintenance labor and materials, electricity, and waste disposal. Typical labor rates and material cost determinations have been determined based on APCCM assumptions. APCCM states that typical operating labor requirements are one-half hour per shift for each scrubber system. It is assumed that the operators will work 548 hours per year, based on 8,760 operating hours per year and eight hours per shift. (8,760 hrs/yr ÷ 8 hrs/shift x 0.5 hr/shift). Based on APCCM, the supervisory labor cost is assumed to be 15 percent of operating labor cost. Maintenance labor is estimated to be 548 hours per year, based on 8,760 operating hours per year and eight hours per shift. (8,760 hrs/yr ÷ 8 hrs/shift x 0.5 hr/shift).

The electricity price of $0.046 per kilowatt-hour was used in the electricity cost determinations. The annual cost of electricity is based on the inlet stream flow rate, pressure drop, and pump/blower size. This cost was determined using the formula found in the APCCM. The scrubber system will also have water, scrubbing solution, and wastewater treatment costs. These costs have been determined using the formulas found in the APCCM.

Indirect annual costs have been determined for the scrubber system. These indirect costs include overhead, taxes, insurance, administrative costs, and capital recovery. Overhead costs are assumed to be 60 percent of operating and maintenance costs, as presented by APCCM. Taxes and insurance are assumed to be one percent of the total capital investment, and administrative costs are assumed to be two percent of the total capital investment. Capital recovery is determined using a factor based on an equipment life of 15 years and an interest rate of seven percent. This factor is then multiplied by the total capital investment.

This cost effectiveness of installing a SO_2 scrubber is based upon the annualized costs divided by the emissions reduction provided by the control technology. The estimated equipment costs for the scrubbing system is $4,000,000 per unit which includes the control system design, stack design, and erection costs. Items not included within the estimate include electrical wiring, control systems, reagent storage/feed systems, utility connections, site preparations, footings/supports, and ducting to the scrubber system.

In order to achieve continuous control of SO_2 emissions, the cost estimate must include the capital cost for two scrubbers, since emissions are routed to either the No.1 or No. 2 combination boilers. However, the operating costs are based on only one scrubber being in use at any time. Using APCCM formulas, the total capital investment for two scrubber systems with supporting equipment has been estimated at $15,360,000. When accounting for annual costs and capital recovery factors, the total annualized cost for the SO_2 controls is $3,825,470.

Based upon the formation of 385.2 tons per year of SO_2 from the modified kraft pulping and evaporator systems and a control efficiency of 90 percent, the cost effectiveness of the control technology is $11,034 per ton of pollutant removed, which is not cost effective.

EVALUATION OF CONTROL COST IMPACTS
KRAFT MILL TRS INCINERATION
ABIBOW US INC.
CATAWBA, SOUTH CAROLINA

Control System	SO_2 Loading (tpy)	SO_2 Outlet (tpy)	Percent Reduction	SO_2 Emissions Reduction (tpy)	Total Annualized Cost	
					($/yr)	($/ton)
SO_2 Scrubber (90%)	385.2	38.5	90.00%	346.7	$ 3,825,470	$ 11,034

The control technology will also generate large volumes of acidic wastewater for treatment within the existing system and may require supplemental heating of the exhaust gases to prevent the formation of a visible plume.

ANNUALIZED COST ANALYSIS

ABIBOW US INC.
CATAWBA, SOUTH CAROLINA
KRAFT MILL TRS INCINERATION
SO_2 SCRUBBER

Cost Item	Computation Method					Cost (Dollars) SCRUBBER
Total Basic Equipment (A)	Vendor Information per unit (2 total)					$4,000,000
Purchased Equipment Cost (B)	Subtotal of above					$8,000,000
Direct Installation Costs (DIC)	Air Pollution Cost Control Manual - 6th Edition					$4,480,000
Modifications to ductwork	Air Pollution Cost Control Manual - 6th Edition					$80,000
Total Direct Costs (DC)	Subtotal of above					$12,560,000
Indirect Costs (IC)	Air Pollution Cost Control Manual - 6th Edition					$2,800,000
TOTAL CAPITAL INVESTMENT (E)	VENDOR INFORMATION					**$15,360,000**
Direct Operating Costs						
Operator	20.00	$/hr	x	548	hr/yr	$10,950
Supervisory Labor	15% of operator labor cost					$1,643
Operating Materials	As Required					
Maintenance (general)						
Labor	20.00	$/hr	x	548	hr/yr	$10,950
Materials	100% of maintenance labor cost					$10,950
Replacement Parts	none (3)					$0
Utilities	Vendor Estimates					
Electricity	0.05	$/kWh	x	2,668,464	kWh/yr	$ 122,749
Fuel Oil		$/gal	x		gal/yr	$ -
Gas	0.00	$/1000 ft^3	x		1000 ft^3/yı	$ -
Water	0.20	$/1000 gal	x	64,411	1000 gal/yr	$ 12,882
Steam	4.65	$/1000 lb	x		1000 lb/yr	$ -
Caustic	300.00	$/2000 lb	x	2,803	1000 lb/yr	$ 840,960
Waste Disposal		$/ton	x		ton/yr	$ -
Wastewater Treatment	3.8	$/1000 gal	x	129,696	1000 gal/yr	$ 492,845
TOTAL DIRECT COSTS (A)	Subtotal of above					**$1,503,929**

Cost Item	Computation Method					Cost (Dollars) SCRUBBER
Indirect Operating Costs						
Overhead	60% of O/M labor costs (a+b)					$20,696
Property Tax	1% of capital costs (G)					$153,600
Insurance	1% of capital costs (G)					$153,600
Administration	2% of capital costs (G)					$307,200
Capital Recovery	CRF = i (1+ i) ^ n / ((1+i)^ n-1) ; i= interest rate , n= years					0.1098
	(7% for 15 yr) x (capital costs + pulp production losses)					$1,686,445
TOTAL FIXED COSTS (B)	Subtotal of above					**$2,321,541**
TOTAL CREDITS (minus C)						
Product Recovery	0.00	$/ton	x	0	tons/yr	
Heat Recovery (4)	0.00	$/10^6 Btu	x	0	10^6/Btu/yr	
TOTAL ANNUALIZED COSTS (D)	(A+B)					**$3,825,470**

5.2.1.4 Selection of BACT

AbiBow has concluded that wet scrubbers are not a cost effective control methodology, and their use would result in increased wastewater treatment considerations and corrosion concerns. Due to the high operating temperatures, the water and caustic soda usage may increase significantly due to evaporation. Furthermore, the addition of a wet scrubber may impact boiler efficiency or controls.

Therefore, BACT for SO_2 emissions resulting from combustion of kraft mill TRS emissions in the No. 1 and No. 2 combination boilers to comply with NSPS subpart BB is continued use of the LVHC collection system TRS scrubber.

The RBLC contains two BACT determinations (PA-0177 and AL-0099) with SO_2 emission rates of 7.7 and 8.4 lb/ADTP, for an average of 8.05 lb/ADTP. However, determination PA-0177 includes only the incineration of the HVLC gases, and determination AL-0099 is for a non-kraft pulping system. The expected SO_2 emission rate from all kraft mill sources is likely to be more than double this value (16.1 lb/ADTP) after accounting for the LVHC gases from kraft mill PA-0177 and making adjustments for non-kraft pulp mill AL-0099.

The SO_2 emissions at the Catawba mill may be less than 16.1 lb/ADTP since the Catawba mill operates a TRS scrubber which removes approximately 50% of the TRS from the LVHC gases prior to incineration. An adjusted SO_2 emission rate of 12.1 lb/ADTP (8.05 plus one-half of 8.05) may be more representative for the Catawba mill. At the permitted capacity of the Catawba kraft pulping system of 1,825 ADTP/day, this emission level would correspond to a maximum SO_2 emission rate of approximately 920 lb/hr and 4,030 tons per year. This represents the maximum SO_2 emissions from all kraft pulping sources at the Catawba mill, not the SO_2 emissions increase associated with the modified sources.